Analysis of Subsurface Velocity Data from the Arctic Ocean

Albert J. Plueddemann
202A Clark Lab, MS-29
Woods Hole Oceanographic Institution
Woods Hole, MA 02541-1541
ph: (508) 289-2789, fax: (508) 457-2163
email: aplueddemann@whoi.edu
Award Number: N00014-97-1-0135
web site: http://ioeb.whoi.edu

LONG TERM GOAL

The long-range goal is to document the characteristics of the subsurface velocity field in the Arctic Ocean and investigate the dynamics, which determine those characteristics.

OBJECTIVES

The specific objectives of this work are (1) to determine the role of low-frequency waves in the generation and propagation of near-inertial internal waves over the Yermak Plateau, and (2) to document the regional and temporal variability of internal waves, tides, and eddies in the Beaufort Sea.

APPROACH

Subsurface velocity data spanning the upper 250 m of the water column have been obtained from Acoustic Doppler Current Profilers (ADCPs) deployed on two special purpose Arctic drifting buoys, denoted Ice-Ocean Environmental Buoys (IOEBs, Honjo et al., 1990; Krishfield et al., 1993). One buoy drifted over the Yermak Plateau and the other made a partial circuit around the Beaufort Gyre. The Yermak Plateau data are being analyzed cooperatively with Konstantin Sabinin and his colleagues at the Andreyev Acoustics Institute in Moscow. The Beaufort Gyre data are being analyzed cooperatively with investigators at the Japan Marine Science Technology Center (JAMSTEC).

WORK COMPLETED

A manuscript describing analysis of the Yermak Plateau data has been completed (Konyaev et al., submitted). Software to acquire and process telemetered subsurface velocity data from the ADCP on the Beaufort Gyre IOEB has been developed and applied. Internally recorded data from the ADCP have also been recovered and processed. A description of initial results from the Beaufort Gyre analysis has been published (Plueddemann et al., 1998a).

Some resources from this grant were used to complete an investigation of the Barents Sea Polar Front (BSPF) begun under another grant (N00014-90-J-1359). An analysis of historical hydrographic data in the region of the BSPF was published (Harris et al., 1998) and summaries of

Report Documentation Page			Form Approved OMB No. 0704-0188
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.			
1. REPORT DATE **1998**	2. REPORT TYPE		3. DATES COVERED **00-00-1998 to 00-00-1998**
4. TITLE AND SUBTITLE **Analysis of Subsurface Velocity Data from the Arctic Ocean**			5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)			5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Woods Hole Oceanographic Institution,Department of Physical Oceanography,Woods Hole,MA,02543**			8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**			
13. SUPPLEMENTARY NOTES **See also ADM002252.**			
14. ABSTRACT			
15. SUBJECT TERMS			
16. SECURITY CLASSIFICATION OF:		17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**4**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

our work on the BSPF were presented at the Fedorov Memorial Symposium on Fronts and Related Phenomena (Plueddemann et al., 1998b; Konyaev et al., 1998).

RESULTS

Wavenumber-frequency spectra of velocities over the Yermak Plateau showed isolated, upward propagating near-inertial wave groups, consistent with the suggestions of Plueddemann (1992) and D'Asaro and Morison (1992). The temporal variability of these spectra showed that the near-inertial wave groups occurred in the presence of low-frequency baroclinic waves. The low-frequency wave field showed both upward and downward propagation and often has the character of standing waves in the vertical. Near-inertial wave parameters varied in time and depth due to changes in background stratification and shear. The most intense near-inertial waves appeared near the high-shear zones of the low-frequency waves. It is hypothesized that refraction by the low-frequency shear led to this intensification.

Time-evolving spectral analysis was used to examine velocity variability from the Beaufort Gyre IOEB in three frequency bands: an eddy band (2–5 day periods), a diurnal band, and a semidiurnal band. The eddy band and the semidiurnal band dominated the horizontal kinetic energy (Figure 1). Eddy energy was clearly confined to the Beaufort Sea and Canada basin, consistent with previous reports (Manley and Hunkins, 1985; D'Asaro, 1988). However, eddies were found further to the south and west than in previous observations. The semidiurnal band was dominated by near-inertial motions with amplitude that varied seasonally (largest in late summer and smallest in late winter). The expectation of an enhanced diurnal tide over the Chukchi Shelf (Kowalik and Proshutinsky, 1993) was borne out in the observations, but the predicted enhancement over the northwest Chukchi Plateau was not observed.

IMPACT/APPLICATIONS

The successful IOEB program in the Beaufort Gyre, and in particular the collection and processing of telemetered subsurface data, has proven the potential of these innovative platforms for research in the remote Arctic. Plans are underway to build on this success in future Arctic field work.

TRANSITIONS

The ADCP interface and satellite transmission scheme developed for the Beaufort Gyre program were applied to an IOEB deployed during the Surface Heat Budget of the Arctic (SHEBA) program in 1997–1998. The ADCP analysis software developed for the Beaufort Gyre project will be applied to processing of the SHEBA ADCP data.

RELATED PROJECTS

The analysis of subsurface velocity data from the Yermak Plateau and Beaufort Gyre was made possible by the ongoing program of Arctic drifting buoy development led by Sus Honjo and performed in cooperation with ONR and JAMSTEC.

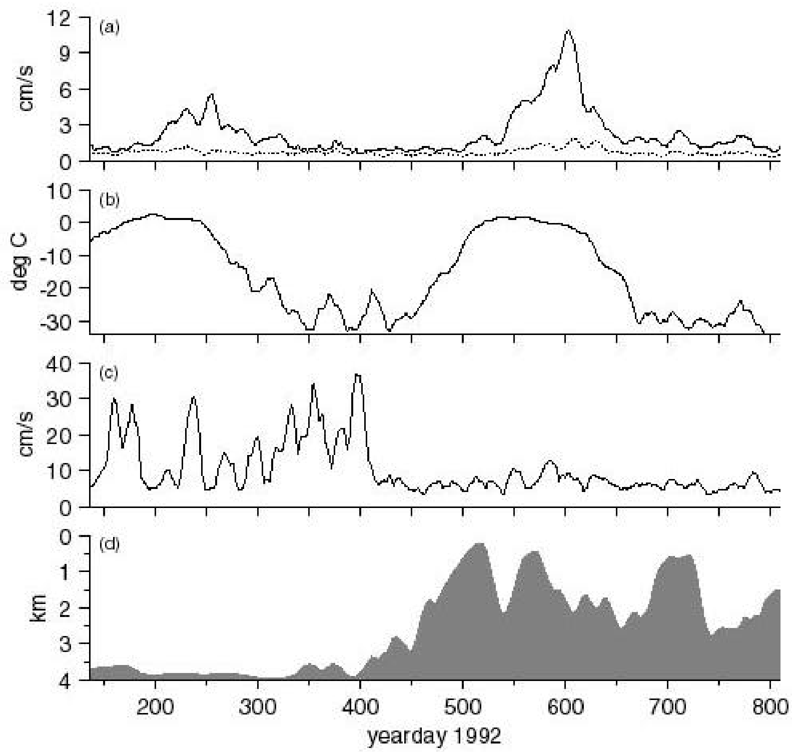

Figure 1: Inertial-band and eddy-band amplitudes. (a) Inertial-band amplitudes separated into clockwise (solid) and counter-clockwise (dotted) components and averaged from the surface to the second ADCP bin (106 m). (b) Air temperature observed at the IOEB (the sensor could not register temperatures less than –35°C). (c) Eddy-band amplitudes averaged over ADCP depth bins 2–3 (106–154 m). (d) Water depth along the drift track.

REFERENCES

D'Asaro, E.A., 1988. Observations of small eddies in the Beaufort Sea. J. Geophys. Res., 93(C6), 6669-6684.

D'Asaro, E.A., and J.H. Morison, 1992. Internal waves and mixing in the Arctic Ocean. Deep-Sea Res., 39, Suppl. 2, 459-484.

Honjo, S., R. Krishfield, and A. Plueddemann, 1990. The Arctic Environmental Drifting Buoy (AEDB): Report of field operations and results. WHOI Technical Report, WHOI-90-02, 128 pp.

Kowalik, Z., and A.Y. Proshutinsky, 1993. Diurnal tides in the Arctic Ocean, J. Geophys. Res., 98, 16,449-16,468.

Krishfield, R., K. Doherty, and S. Honjo, 1993. Ice-Ocean Environmental Buoys (IOEB): Technology and Development in 1991-1992. WHOI Technical Report, WHOI-93-45, 138 pp.

Manley, T.O., and K. Hunkins, 1985. Mesoscale eddies of the Arctic Ocean. J. Geophys. Res., 90(C3), 4911-4930.

Plueddemann, A.J., 1992. Internal wave measurements from the Arctic Environmental Drifting Buoy. J. Geophys. Res., 97(C8), 12,619-12,638.

PUBLICATIONS

Harris, C.L., A.J. Plueddemann, and G.G. Gawarkiewicz, 1998. Water mass distribution and polar front structure in the western Barents Sea, J. Geophys. Res., 103(C2), 2905-2917.

Konyaev, K.V., A.J. Plueddemann, and K.D. Sabinin. Semi-diurnal internal waves over the Yermak Plateau and their connection with low-frequency currents. Deep-Sea Research, submitted.

Konyaev, K.V., G.I. Kozoubskaya, A.J. Plueddemann, and K.D. Sabinin, 1998. Internal waves at the Barents Sea Polar Front, Proc. Fedorov Memorial Symposium, St. Petersburg, Russia, 18-22 May 1998.

Plueddemann, A.J. R. Krishfield, S. Honjo, T. Takazawa, and K. Hatakeyama, 1998a. Upper ocean velocities in the Beaufort Gyre, Geophys. Res. Lett., 25(2), 183-186.

Plueddemann, A.J., G.G. Gawarkiewicz, and C.L. Harris, 1998b. The Barents Sea Polar Front: Topographic control and seasonal variability, Proc. Fedorov Memorial Symposium, St. Petersburg, Russia, 18-22 May 1998.